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(54) **CREATING AN ON-DEMAND BLUEPRINT OF A MOBILE APPLICATION**

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G06F 8/65	(2018.01)
G06F 3/048	(2013.01)
G06F 9/451	(2018.01)
H04L 29/08	(2006.01)
G06F 3/0482	(2013.01)
G06F 17/00	(2019.01)

(52) **U.S. Cl.**

CPC ***G06F 9/451*** (2018.02); ***G06F 3/048*** (2013.01); ***G06F 8/33*** (2013.01); *G06F 3/0482* (2013.01); *G06F 8/61* (2013.01); *G06F 8/65* (2013.01); *H04L 67/1095* (2013.01)

(58) **Field of Classification Search**

CPC G06F 9/451; G06F 9/443; G06F 3/0482; G06F 17/3867; G06F 17/3053; G06F 8/61; G06F 8/65; G06F 8/39; H04L 67/1095

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,843,633 B2	9/2014	Eriksson et al.
9,003,406 B1	4/2015	Hodge et al.

(Continued)

OTHER PUBLICATIONS

Anonymously; Application Centric Framework to Smart Discover and Adapt Services for Applications, May 13, 2014.

(Continued)

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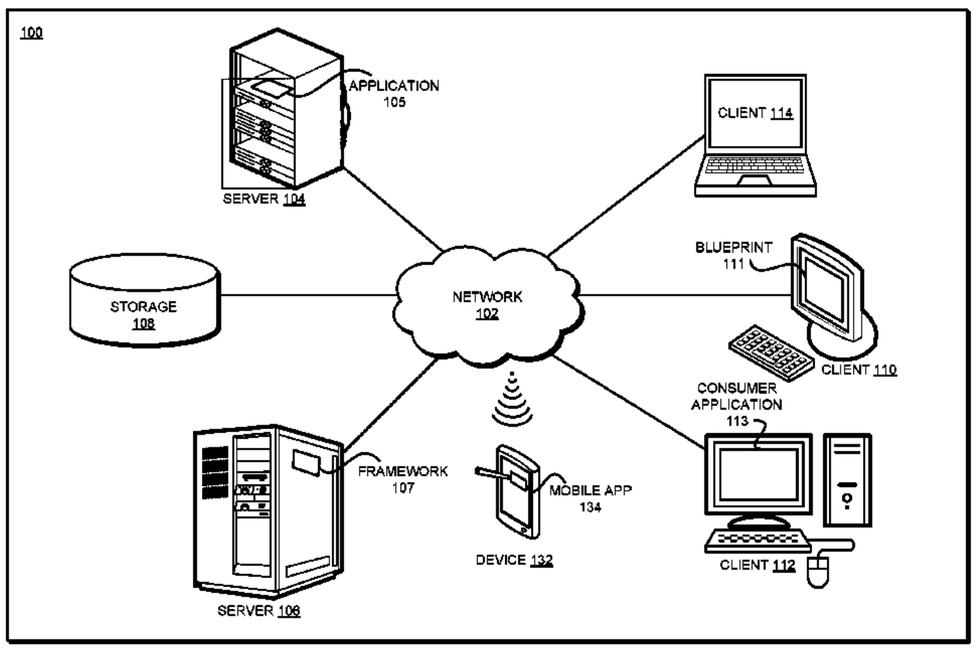
(74) *Attorney, Agent, or Firm* — Garg Law Firm, PLLC; Rakesh Garg; Christopher K. McLane

(57) **ABSTRACT**

An analysis of a mobile app is performed to determine each UI configuration in a set of UI configurations that is reachable in a possible use of the mobile app. A set of elements is detected that is used in the mobile app relative to a selected UI configuration from the set. A function performed by a selected element relative to the selected UI configuration is analyzed and matched with a function identified in a hierarchy of elements. The hierarchy is applicable to several mobile apps. A category of the function identified in the hierarchy is assigned to the selected element. The category and a numerosity of occurrences of the selected element in the mobile app are output in a blueprint of the mobile app.

19 Claims, 5 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

9,043,747	B2	5/2015	Eksten et al.	
2014/0109046	A1*	4/2014	Hirsch	G06F 9/44 717/120
2014/0380308	A1	12/2014	Hassine et al.	
2017/0032050	A1*	2/2017	Kol	G06F 3/0482

OTHER PUBLICATIONS

Anonymously; Method to display, modify, and collaborate on files of any format type by a cloud-like environment, Dec. 2, 2013. Appendix P, 2016.

* cited by examiner

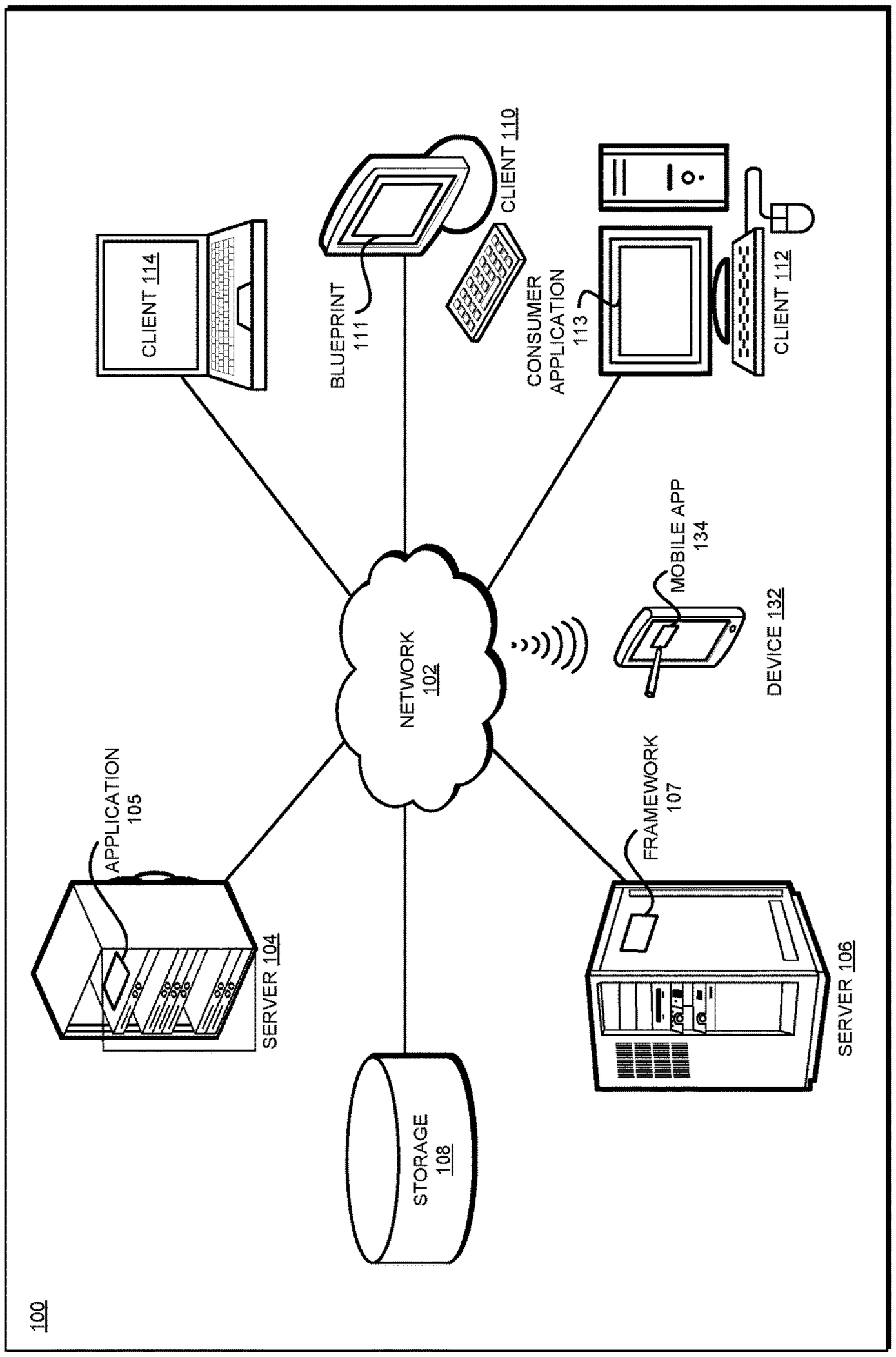

CLIENT 110
CLIENT 114
BLUEPRINT 111
CONSUMER APPLICATION 113
CLIENT 112
NETWORK 102
MOBILE APP 134
DEVICE 132
APPLICATION 105
FRAMEWORK 107
SERVER 104
SERVER 106
STORAGE 108
100

FIGURE 1

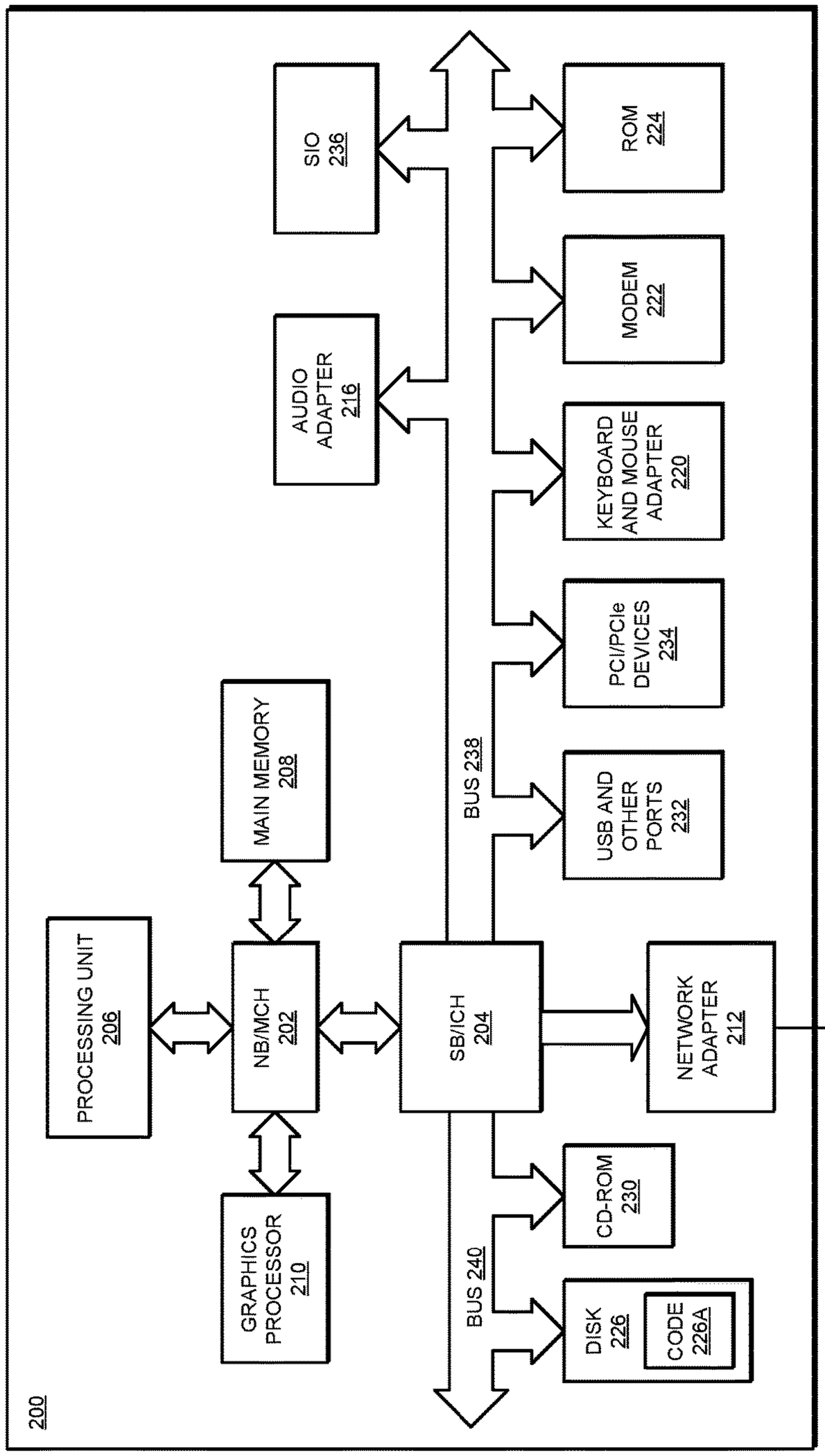

200
PROCESSING UNIT 206
NB/MCH 202
SB/ICH 204
MAIN MEMORY 208
GRAPHICS PROCESSOR 210
BUS 238
BUS 240
AUDIO ADAPTER 216
USB AND OTHER PORTS 232
PCI/PCIe DEVICES 234
KEYBOARD AND MOUSE ADAPTER 220
MODEM 222
ROM 224
CD-ROM 230
DISK 226
CODE 226A
NETWORK ADAPTER 212
NETWORK 201A
REMOTE SYSTEM 201B
STORAGE 201D
CODE 201C

FIGURE 2

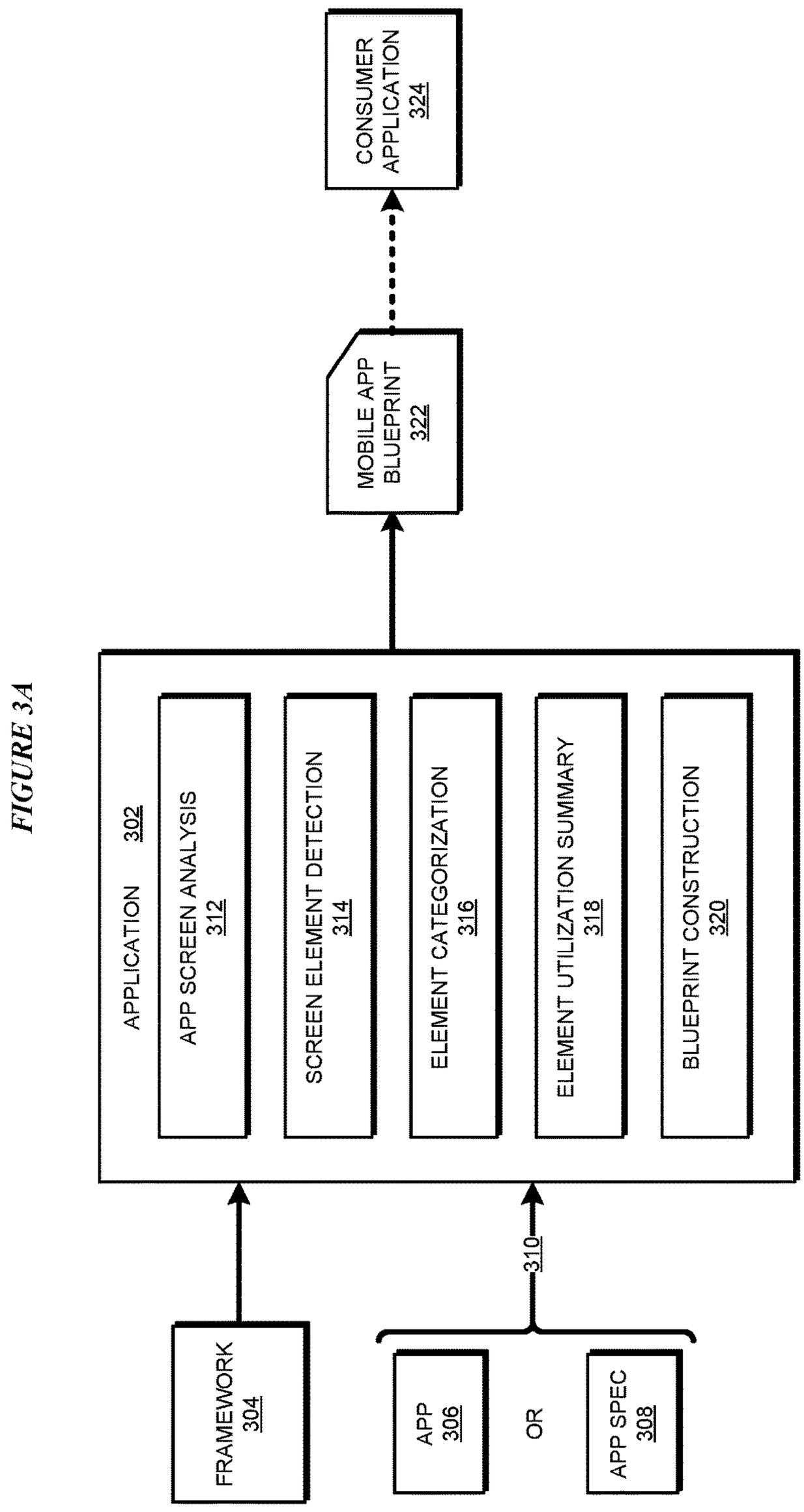

CONSUMER APPLICATION 324
MOBILE APP BLUEPRINT 322
APPLICATION 302
APP SCREEN ANALYSIS 312
SCREEN ELEMENT DETECTION 314
ELEMENT CATEGORIZATION 316
ELEMENT UTILIZATION SUMMARY 318
BLUEPRINT CONSTRUCTION 320
FRAMEWORK 304
310
APP 306
OR
APP SPEC 308

FIGURE 3A

350

ELEMENTS	SUB-ELEMENTS	DETAILED ELEMENTS	SCREEN/COUNT
1.0 APPLICATION CONFIGURATION	1.1 UI CONFIGURATION ELEMENTS	1.1.1 LOGO AND COLOR THEMES 1.1.3 INTERNATIONALIZATION 1.1.2 ERROR MESSAGE CHANGES 1.1.2 LIMIT CONFIGURATIONS	14 14 (NATIVE) 10 MESSAGES 3 CONFIGURATION FILES
2.0 AUTHENTICATION & PERMISSIONS	2.1 AUTHENTICATION	2.1.1 ADVISOR NAME & PASSWORD	1 1
	2.3 SECURITY ELEMENTS	2.3.2 REMEMBER ADVISOR NAME 2.3.3 FORGOT PASSWORD	1
3.0 NOTIFICATION AND COLLABORATION	3.1 NOTIFICATIONS	3.1.1 RECEIVE FINANCIAL MARKET ALERTS AND DISPLAY	2
4.0 FILES, CONTENT AND DATA	4.1 FILES AND CONTENT FORM ENTERPRISE	4.1.2 FINANCIAL DISCLOSURE	1
	4.4 GENERATED BY APP	4.4.4 CHECK IMAGE FRONT AND BACK	1
	4.1 FILES AND CONTENT FORM ENTERPRISE	4.1.2 FINANCIAL DISCLOSURE	1

FIGURE 3B

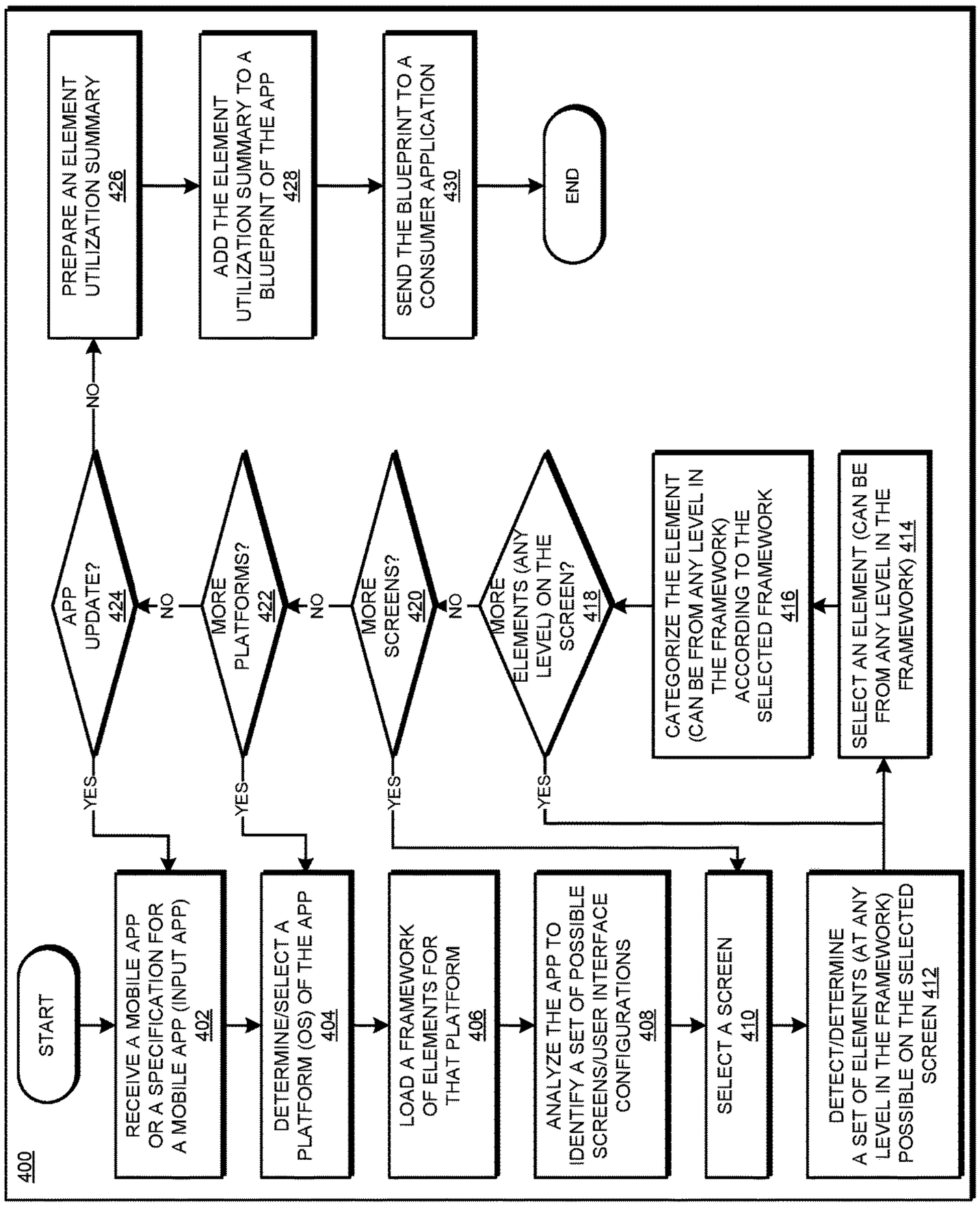

400
START
RECEIVE A MOBILE APP OR A SPECIFICATION FOR A MOBILE APP (INPUT APP) 402
DETERMINE/SELECT A PLATFORM (OS) OF THE APP 404
LOAD A FRAMEWORK OF ELEMENTS FOR THAT PLATFORM 406
ANALYZE THE APP TO IDENTIFY A SET OF POSSIBLE SCREENS/USER INTERFACE CONFIGURATIONS 408
SELECT A SCREEN 410
DETECT/DETERMINE A SET OF ELEMENTS (AT ANY LEVEL IN THE FRAMEWORK) POSSIBLE ON THE SELECTED SCREEN 412
SELECT AN ELEMENT (CAN BE FROM ANY LEVEL IN THE FRAMEWORK) 414
CATEGORIZE THE ELEMENT (CAN BE FROM ANY LEVEL IN THE FRAMEWORK) ACCORDING TO THE SELECTED FRAMEWORK 416
MORE ELEMENTS (ANY LEVEL) ON THE SCREEN? 418
YES
NO
MORE SCREENS? 420
YES
NO
MORE PLATFORMS? 422
YES
NO
APP UPDATE? 424
YES
NO
PREPARE AN ELEMENT UTILIZATION SUMMARY 426
ADD THE ELEMENT UTILIZATION SUMMARY TO A BLUEPRINT OF THE APP 428
SEND THE BLUEPRINT TO A CONSUMER APPLICATION 430
END

FIGURE 4

CREATING AN ON-DEMAND BLUEPRINT OF A MOBILE APPLICATION

TECHNICAL FIELD

The present invention relates generally to a method, system, and computer program product for analyzing mobile applications. More particularly, the present invention relates to a method, system, and computer program product for creating an on-demand blueprint of a mobile application.

BACKGROUND

Wireless communications (mobile communications) enable users to perform a variety of tasks using their mobile devices. An ever increasing number of applications is available for the wireless data processing systems, wireless data communication devices, or wireless computing platforms (collectively and interchangeably, "mobile device" or "mobile devices"). For example, many mobile devices not only allow the users to make voice calls, but also exchange emails and messages, access remote data processing systems, and perform web-based interactions and transactions. Wearable devices are a category of mobile devices. A wearable device is essentially a mobile device, but has a form-factor that is suitable for wearing the device on a user's person.

Hereinafter, a mobile application is interchangeably referred to as simply "mobile app" or "app" unless expressly disambiguated where used. A mobile application is a software application that is designed and configured to operate on a mobile device.

A mobile app comprises user interface components and functional components. A user interface (UI) allows a human user to interact with the app, and a functional component performs a function or operation for which the app is configured. The functional components are subdivided according to functions performed by those components. One type of functional components are integration components, which perform functions related to integration of the mobile app with other applications and systems. Another type of functional components includes functional components which perform app-specific functions other than integration functions.

For example, a map app has a map display UI which presents map information to a user and receives inputs from the user. A map engine implemented in the app collects Global Positioning System (GPS) data, extracts map data from a repository, plots the GPS data relative to map data, collects other information pertinent to the GPS location—e.g. weather or traffic data—from their respective sources, and constructs a map presentation that can be presented on the map UI.

SUMMARY

The illustrative embodiments provide a method, system, and computer program product. An embodiment includes a method that performs, using a processor and a memory, an analysis of a mobile app, the analysis determining each user interface (UI) configuration in a set of UI configurations that is reachable in a possible use of the mobile app. The embodiment detects a set of elements used in the mobile app relative to a selected UI configuration from the set of UI configurations. The embodiment analyzes, using the processor and the memory, a function performed by a selected element from the set of element relative to the selected UI configuration. The embodiment matches the function performed by the selected element with a function identified in a hierarchy of elements, the hierarchy being applicable to a plurality of mobile apps. The embodiment assigns a category of the function identified in the hierarchy to the selected element. The embodiment outputs in a blueprint of the mobile app, the category and a numerosity of occurrences of the selected element in the mobile app.

An embodiment includes a computer program product. The computer program product includes one or more computer-readable storage devices, and program instructions stored on at least one of the one or more storage devices.

An embodiment includes a computer system. The computer system includes one or more processors, one or more computer-readable memories, and one or more computer-readable storage devices, and program instructions stored on at least one of the one or more storage devices for execution by at least one of the one or more processors via at least one of the one or more memories.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of the illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

FIG. **1** depicts a block diagram of a network of data processing systems in which illustrative embodiments may be implemented;

FIG. **2** depicts a block diagram of a data processing system in which illustrative embodiments may be implemented;

FIG. **3**A depicts a block diagram of an example configuration for creating an on-demand blueprint of a mobile application in accordance with an illustrative embodiment;

FIG. **3**B depicts an example blueprint of an example app, in accordance with an illustrative embodiment; and

FIG. **4** depicts a flowchart of an example process for creating an on-demand blueprint of a mobile application in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The illustrative embodiments recognize that being able to use a mobile app is dependent—in a large part—upon understanding the app. If an app is not well understood, it is unlikely that the app will be utilized for its intended purpose with a desired level of success.

For example, some mobile apps, which are referred to as Business to Employee or "B2E" apps, are becoming increasingly prevalent within business enterprises. The employees use B2E mobile apps to perform tasks in the enterprise. These mobile apps are replacing the traditional web based or custom applications that employees have typically used to perform their tasks in the past. Whether an employee is able to complete a task successfully and efficiently using a B2E app is highly dependent on the employee's understanding of the capabilities and functionality of the app, the employee's ability to discover opportunities for reuse of those functionalities for performing other tasks, and many other such factors.

The illustrative embodiments recognize that a user may learn the capabilities and functions of an app by repeated use

over time. The user may also presently learn about the app by using the app in conjunction with the app documentation.

However, the illustrative embodiments recognize that learning-by-using is not a guaranteed way of discovering the various features and functions of a given app. It is a very familiar situation that a seasoned user of an app accidentally discovers a feature of the app after a prolonged use, or may never discover a feature of the app even after a prolonged use.

The illustrative embodiments recognize that learning-from-the-documentation is also not a guaranteed way of discovering the various features and functions of a given app. Many apps do not have sufficient documentation that a user can use. Many apps that do have some documentation, often are woefully deficient in that documentation—often documenting only certain features but not all, and often giving the user no choice in what is included in the documentation and what is omitted therefrom. The illustrative embodiments recognize that given an unfamiliar mobile app, there presently exists no automated way for a user to analyze the mobile app and create a blueprint of the app that reveals the properties of the UI and the functions of the app.

The illustrative embodiments used to describe the invention generally address and solve the above-described problems and other problems related to automatically determining the features and functions of an unfamiliar mobile app.

An embodiment can be implemented as a software application. The application implementing an embodiment can be configured as a modification of an existing system, as a separate application that operates in conjunction with an existing system, a standalone application, or some combination thereof.

A UI or a function of a mobile app comprises a set of elements. An element of a UI (UI element) is an artifact that is visibly presented or presentable on a screen used in the UI. A screen is a graphical layout that is presented or presentable on the UI of the app. An element of a function (function element) of the app is a functional component—e.g., an implementation of a method or generally a portion of computer usable code—which operates to perform an operation configured in the app. A function element can manifest itself as an invisible UI element.

A framework of elements (framework) is a hierarchy of elements of any suitable type, that are available for use in a mobile app on a given operating system (platform). Different sets of elements, different hierarchies of a common set of elements, or some combination thereof, may be available for use on different platforms. Consequently, different frameworks may be applicable to different platforms. From a framework, a mobile app can implement some or all elements in the form of the UI elements of the app, function elements of the app, or both.

A hierarchy of elements is an arrangement of a set of elements according to some dependency, characteristic, or other relationship between the elements. For example, an element may exist under a root node of a hierarchy in an example framework. The element may provide a configuration function where the configuration is applicable to the app as a whole.

An element may act as a parent or a root node for zero or more sub-elements. For example, the app configuration function element may have a sub-element that configures only the UI of the app, and another sub-element that configures only the communications function of the app.

A sub-element may act as a parent or a root node for zero or more detailed elements. For example, the UI configuration sub-element may have one detailed element that configures only the branding visuals on the UI, and another detailed element that configures only the localization or internationalization aspects on the UI.

Generally, any number of the highest level elements, any number of sub-elements below an element, any number of sub-sub-elements below a sub-element, and so on, and any number of levels in a hierarchy in a similar manner are possible and contemplated in a framework. Hereinafter, a reference to an element is contemplated to be representative of a reference to a highest level element, a sub-element, a detailed element, or a sub-sub-element at any level in a given hierarchy, unless expressly distinguished where used. A mobile app may use all or a subset of elements from any combination of the levels represented in a given framework.

A blueprint of an app is a report about the app in which the elements that are used in the app, the category of a used element, the screen or screens relative to which an element is used in the app, a numerosity of the occurrences of an element in a single screen, a numerosity of the occurrences of an element in a plurality of screens of the app, or some combination of these and other data are reported.

A category of an element is a type, category, or classification associated with the element in a framework. Within the scope of the illustrative embodiments, an embodiment can be adapted to construct a blueprint of a mobile app that exists and is operational, or of a mobile app that has only been specified in a specification but does not yet exist or is not yet fully operational.

As an example, consider a non-limiting simplified blueprint of an example financial service app, which is depicted in FIG. **3**B. Blueprint **350** shows a set of element categories, e.g., element **1.0** of "app configuration" category, element **2.0** of "Authentication and permissions category", and so on. Similarly, various sub-elements and detailed elements corresponding to these and other elements are classified and described in this example blueprint. The "screens/Count" column of blueprint **350** shows the numerosity of the occurrences of a depicted element in one or more screens of the example financial service app.

An embodiment receives a mobile app or a specification of a mobile app. For example, the embodiment may be supplied a reference to an app that is stored or is storable on a mobile device, or a reference to a document that forms the specification for the mobile app.

The app or the specification or a reference to either the app or the specification, which form an input to an embodiment, are collectively and interchangeably referred to herein as an input app. Depending upon the platform for which the input app is configured, the embodiment loads a suitable platform-specific framework. When the input app is provided for multiple platforms, the embodiment selects one platform and loads the framework for the selected platform at a time.

The embodiment analyzes the input app to identify a set of screens to which navigation within the input app is possible. For each selected screen in the set, the embodiment detects or otherwise determines a set of elements. Recall that the set of elements related to the screen can include any combination of UI elements and function elements, where such elements can be represented at any level in the selected framework.

The embodiment categorizes each element from the set of elements according to the one or more categories assigned to the element or a similar element in the selected framework. For example, the input app may use a modified form of an element that performs more than one functions, which therefore maps the used element to more than one elements

in the selected framework, and can therefore be categorized into more than one categories according to the categories of those elements the framework.

The embodiment categorizes each element in each screen of the input app. While categorizing, the embodiment also tracks the number of times an element has been used relative to a particular screen, the number of times the element has been used relative to any screen in the input app, or some combination thereof. The embodiment uses this tracking to construct a utilization summary for each element, each screen, and each platform applicable to the input app.

The embodiment constructs a blueprint of the input app by detailing, in a report of any suitable form, the detected elements of the input app, the categories of the detected elements, the interdependencies or relationships of a detected element with other elements in the input app, the utilization summaries corresponding to the detected elements, or some combination thereof as may be suitable in a given implementation. The blueprint is usable by a user for understanding the features and functions of the input app, or is consumable by a consumer app for further processing relative to the input app.

Such a blueprint cannot be constructed manually at least because many elements cannot be identified manually in a mobile app. Such a blueprint cannot also be created via the documentation of the app for similar reasons.

A method of an embodiment described herein, when implemented to execute on a device or data processing system, comprises substantial advancement of the functionality of that device or data processing system in revealing the features and functions of a mobile app on demand. For example, presently available methods for understanding a mobile app rely on learning-by-using in most cases, or learning from preconfigured documents in some cases. An embodiment automatically and on demand analyzes a mobile app and produces a comprehensive blueprint of the mobile app. The blueprint is configurable according to the particular need of a user or consumer application, and can be re-constructed through reanalysis as and when a mobile app is changed or updated. This manner of creating an on-demand blueprint of a mobile application is unavailable in the presently available methods. Thus, a substantial advancement of such devices or data processing systems by executing a method of an embodiment is in sufficiently and automatically revealing the functions and features of unknown mobile apps on demand.

The illustrative embodiments are described with respect to certain types of apps, UI, functions, elements, categories, hierarchies, platforms, utilizations, summaries, devices, data processing systems, environments, components, and applications only as examples. Any specific manifestations of these and other similar artifacts are not intended to be limiting to the invention. Any suitable manifestation of these and other similar artifacts can be selected within the scope of the illustrative embodiments.

Furthermore, the illustrative embodiments may be implemented with respect to any type of data, data source, or access to a data source over a data network. Any type of data storage device may provide the data to an embodiment of the invention, either locally at a data processing system or over a data network, within the scope of the invention. Where an embodiment is described using a mobile device, any type of data storage device suitable for use with the mobile device may provide the data to such embodiment, either locally at the mobile device or over a data network, within the scope of the illustrative embodiments.

The illustrative embodiments are described using specific code, designs, architectures, protocols, layouts, schematics, and tools only as examples and are not limiting to the illustrative embodiments. Furthermore, the illustrative embodiments are described in some instances using particular software, tools, and data processing environments only as an example for the clarity of the description. The illustrative embodiments may be used in conjunction with other comparable or similarly purposed structures, systems, applications, or architectures. For example, other comparable mobile devices, structures, systems, applications, or architectures therefor, may be used in conjunction with such embodiment of the invention within the scope of the invention. An illustrative embodiment may be implemented in hardware, software, or a combination thereof.

The examples in this disclosure are used only for the clarity of the description and are not limiting to the illustrative embodiments. Additional data, operations, actions, tasks, activities, and manipulations will be conceivable from this disclosure and the same are contemplated within the scope of the illustrative embodiments.

Any advantages listed herein are only examples and are not intended to be limiting to the illustrative embodiments. Additional or different advantages may be realized by specific illustrative embodiments. Furthermore, a particular illustrative embodiment may have some, all, or none of the advantages listed above.

With reference to the figures and in particular with reference to FIGS. **1** and **2**, these figures are example diagrams of data processing environments in which illustrative embodiments may be implemented. FIGS. **1** and **2** are only examples and are not intended to assert or imply any limitation with regard to the environments in which different embodiments may be implemented. A particular implementation may make many modifications to the depicted environments based on the following description.

FIG. **1** depicts a block diagram of a network of data processing systems in which illustrative embodiments may be implemented. Data processing environment **100** is a network of computers in which the illustrative embodiments may be implemented. Data processing environment **100** includes network **102**. Network **102** is the medium used to provide communications links between various devices and computers connected together within data processing environment **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

Clients or servers are only example roles of certain data processing systems connected to network **102** and are not intended to exclude other configurations or roles for these data processing systems. Server **104** and server **106** couple to network **102** along with storage unit **108**. Software applications may execute on any computer in data processing environment **100**. Clients **110**, **112**, and **114** are also coupled to network **102**. A data processing system, such as server **104** or **106**, or client **110**, **112**, or **114** may contain data and may have software applications or software tools executing thereon.

Only as an example, and without implying any limitation to such architecture, FIG. **1** depicts certain components that are usable in an example implementation of an embodiment. For example, servers **104** and **106**, and clients **110**, **112**, **114**, are depicted as servers and clients only as example and not to imply a limitation to a client-server architecture. As another example, an embodiment can be distributed across several data processing systems and a data network as shown, whereas another embodiment can be implemented on a single data processing system within the scope of the

illustrative embodiments. Data processing systems **104**, **106**, **110**, **112**, and **114** also represent example nodes in a cluster, partitions, and other configurations suitable for implementing an embodiment.

Device **132** is an example of a device described herein. For example, device **132** can take the form of a smartphone, a tablet computer, a laptop computer, client **110** in a stationary or a portable form, a wearable computing device, or any other suitable device. Any software application described as executing in another data processing system in FIG. **1** can be configured to execute in device **132** in a similar manner. Any data or information stored or produced in another data processing system in FIG. **1** can be configured to be stored or produced in device **132** in a similar manner.

Application **105** implements an embodiment described herein. Application **105** uses framework **107** to produce blueprint **111** of mobile app **134** as described herein. Consumer application **113** consumes or uses blueprint **111** in any manner suitable according to an implementation.

Servers **104** and **106**, storage unit **108**, and clients **110**, **112**, and **114** may couple to network **102** using wired connections, wireless communication protocols, or other suitable data connectivity. Clients **110**, **112**, and **114** may be, for example, personal computers or network computers.

In the depicted example, server **104** may provide data, such as boot files, operating system images, and applications to clients **110**, **112**, and **114**. Clients **110**, **112**, and **114** may be clients to server **104** in this example. Clients **110**, **112**, **114**, or some combination thereof, may include their own data, boot files, operating system images, and applications. Data processing environment **100** may include additional servers, clients, and other devices that are not shown.

In the depicted example, data processing environment **100** may be the Internet. Network **102** may represent a collection of networks and gateways that use the Transmission Control Protocol/Internet Protocol (TCP/IP) and other protocols to communicate with one another. At the heart of the Internet is a backbone of data communication links between major nodes or host computers, including thousands of commercial, governmental, educational, and other computer systems that route data and messages. Of course, data processing environment **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). FIG. **1** is intended as an example, and not as an architectural limitation for the different illustrative embodiments.

Among other uses, data processing environment **100** may be used for implementing a client-server environment in which the illustrative embodiments may be implemented. A client-server environment enables software applications and data to be distributed across a network such that an application functions by using the interactivity between a client data processing system and a server data processing system. Data processing environment **100** may also employ a service oriented architecture where interoperable software components distributed across a network may be packaged together as coherent business applications.

With reference to FIG. **2**, this figure depicts a block diagram of a data processing system in which illustrative embodiments may be implemented. Data processing system **200** is an example of a computer, such as servers **104** and **106**, or clients **110**, **112**, and **114** in FIG. **1**, or another type of device in which computer usable program code or instructions implementing the processes may be located for the illustrative embodiments.

Data processing system **200** is also representative of a data processing system or a configuration therein, such as data processing system **132** in FIG. **1** in which computer usable program code or instructions implementing the processes of the illustrative embodiments may be located. Data processing system **200** is described as a computer only as an example, without being limited thereto. Implementations in the form of other devices, such as device **132** in FIG. **1**, may modify data processing system **200**, such as by adding a touch interface, and even eliminate certain depicted components from data processing system **200** without departing from the general description of the operations and functions of data processing system **200** described herein.

In the depicted example, data processing system **200** employs a hub architecture including North Bridge and memory controller hub (NB/MCH) **202** and South Bridge and input/output (I/O) controller hub (SB/ICH) **204**. Processing unit **206**, main memory **208**, and graphics processor **210** are coupled to North Bridge and memory controller hub (NB/MCH) **202**. Processing unit **206** may contain one or more processors and may be implemented using one or more heterogeneous processor systems. Processing unit **206** may be a multi-core processor. Graphics processor **210** may be coupled to NB/MCH **202** through an accelerated graphics port (AGP) in certain implementations.

In the depicted example, local area network (LAN) adapter **212** is coupled to South Bridge and I/O controller hub (SB/ICH) **204**. Audio adapter **216**, keyboard and mouse adapter **220**, modem **222**, read only memory (ROM) **224**, universal serial bus (USB) and other ports **232**, and PCI/PCIe devices **234** are coupled to South Bridge and I/O controller hub **204** through bus **238**. Hard disk drive (HDD) or solid-state drive (SSD) **226** and CD-ROM **230** are coupled to South Bridge and I/O controller hub **204** through bus **240**. PCI/PCIe devices **234** may include, for example, Ethernet adapters, add-in cards, and PC cards for notebook computers. PCI uses a card bus controller, while PCIe does not. ROM **224** may be, for example, a flash binary input/output system (BIOS). Hard disk drive **226** and CD-ROM **230** may use, for example, an integrated drive electronics (IDE), serial advanced technology attachment (SATA) interface, or variants such as external-SATA (eSATA) and micro-SATA (mSATA). A super I/O (SIO) device **236** may be coupled to South Bridge and I/O controller hub (SB/ICH) **204** through bus **238**.

Memories, such as main memory **208**, ROM **224**, or flash memory (not shown), are some examples of computer usable storage devices. Hard disk drive or solid state drive **226**, CD-ROM **230**, and other similarly usable devices are some examples of computer usable storage devices including a computer usable storage medium.

An operating system runs on processing unit **206**. The operating system coordinates and provides control of various components within data processing system **200** in FIG. **2**. The operating system may be a commercially available operating system. An object oriented programming system may run in conjunction with the operating system and provide calls to the operating system from programs or applications executing on data processing system **200**.

Instructions for the operating system, the object-oriented programming system, and applications or programs, such as application **105** in FIG. **1**, are located on storage devices, such as in the form of code **226**A on hard disk drive **226**, and may be loaded into at least one of one or more memories, such as main memory **208**, for execution by processing unit **206**. The processes of the illustrative embodiments may be performed by processing unit **206** using computer imple-

mented instructions, which may be located in a memory, such as, for example, main memory **208**, read only memory **224**, or in one or more peripheral devices.

Furthermore, in one case, code **226**A may be downloaded over network **201**A from remote system **201**B, where similar code **201**C is stored on a storage device **201**D. In another case, code **226**A may be downloaded over network **201**A to remote system **201**B, where downloaded code **201**C is stored on a storage device **201**D.

The hardware in FIGS. **1-2** may vary depending on the implementation. Other internal hardware or peripheral devices, such as flash memory, equivalent non-volatile memory, or optical disk drives and the like, may be used in addition to or in place of the hardware depicted in FIGS. **1-2**. In addition, the processes of the illustrative embodiments may be applied to a multiprocessor data processing system.

In some illustrative examples, data processing system **200** may be a personal digital assistant (PDA), which is generally configured with flash memory to provide non-volatile memory for storing operating system files and/or user-generated data. A bus system may comprise one or more buses, such as a system bus, an I/O bus, and a PCI bus. Of course, the bus system may be implemented using any type of communications fabric or architecture that provides for a transfer of data between different components or devices attached to the fabric or architecture.

A communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. A memory may be, for example, main memory **208** or a cache, such as the cache found in North Bridge and memory controller hub **202**. A processing unit may include one or more processors or CPUs.

The depicted examples in FIGS. **1-2** and above-described examples are not meant to imply architectural limitations. For example, data processing system **200** also may be a tablet computer, laptop computer, or telephone device in addition to taking the form of a mobile or wearable device.

Where a computer or data processing system is described as a virtual machine, a virtual device, or a virtual component, the virtual machine, virtual device, or the virtual component operates in the manner of data processing system **200** using virtualized manifestation of some or all components depicted in data processing system **200**. For example, in a virtual machine, virtual device, or virtual component, processing unit **206** is manifested as a virtualized instance of all or some number of hardware processing units **206** available in a host data processing system, main memory **208** is manifested as a virtualized instance of all or some portion of main memory **208** that may be available in the host data processing system, and disk **226** is manifested as a virtualized instance of all or some portion of disk **226** that may be available in the host data processing system. The host data processing system in such cases is represented by data processing system **200**.

With reference to FIG. **3**, this figure depicts a block diagram of an example configuration for creating an on-demand blueprint of a mobile application in accordance with an illustrative embodiment. Application **302** is an example of application **105** in FIG. **1**.

Framework **304**, which is an example of framework **107** in FIG. **1**, forms an input to application **302**. Mobile app **306** or specification **308** of a mobile app forms input app **310** as described herein, and is another input to application **302**.

Component **312** analyzes input app **310** to identify a set of screens that are navigationally possible in input app **310**. Component **314** detects or otherwise determines an element used in a screen, e.g., a UI element, or in conjunction with a screen, e.g., a function element. Component **314** detects a set of elements used in input app **310** in this manner.

Component **316** categorizes a detected element according to framework **304**. Component **318** computes a utilization summary of the element as described herein. Thus, components **316** and **318** process each element from the set of elements detected in input app **310** by component **314**.

Component **320** constructs blueprint **322** of input app **310**. Consumer application **324** consumes or uses blueprint **322**.

With reference to FIG. **4**, this figure depicts a flowchart of an example process for creating an on-demand blueprint of a mobile application in accordance with an illustrative embodiment. Process **400** can be implemented in application **302** in FIG. **3**.

The application receives a mobile app or a specification for a mobile app, i.e., the input app as described herein (block **402**). The application determines or selects an operating system, i.e., a platform, for which the input app has to be blueprinted (block **404**).

The application loads a framework corresponding to the selected platform (block **406**). The application analyzes the app to identify a set of possible screens or UI configurations that are reachable during a possible use of, or a manner of operating, the input app (block **408**). The application selects a screen (block **410**).

The application detects or otherwise determines a set of elements that are used or can be possibly used on or relative to the selected screen during a use of, or a manner of operating, the input app (block **412**). Recall that an element in the set of elements can be a highest level element, a sub-element, a detailed element, or generally an element appearing at any level in the given hierarchy.

The application selects an element from the set of elements (block **414**). The selected element can be from any level of the loaded framework.

The application determines a category that is applicable to the element based on a manner in which the element is used in the input app. Particularly, the application matches the element to a node element in the selected framework according to one or more of the element's functionality, manner of use relative to the screen, and/or a purpose for which the element is used relative to the screen, and the matching identifies one or more categories that are applicable to the selected element (block **416**).

The application determines whether more elements remain in the set of elements corresponding to the selected screen (block **418**). If, for the selected screen, more elements from any level of the framework remain to be categorized ("Yes" path of block **418**), the application returns to block **414** and selects another element.

If no more elements of the selected screen remain to be categorized ("No" path of block **418**), the application determines whether more screens remain in the set of screens for analysis (block **420**). If more screens remain for analysis ("Yes" path of block **420**), the application returns to block **414** and selects another screen.

If no more screens remain for analysis ("No" path of block **420**), the application determines whether more platforms are applicable to the input app (block **422**). If more platforms are applicable to the input app ("Yes" block **422**), the application returns to block **404** and selects another platform.

If the input app need not be analyzed for more platforms ("No" path of block **422**), the application determines whether the input app has been updated (block **424**). If the

input app has been updated ("Yes" path of block **424**), the application returns to block **402** and receives the updated input app into process **400**.

If the input app has not been updated ("No" path of block **424**), the application prepares an element utilization summary for each element used in the input app (block **426**). The application adds the element information as described herein and the element utilization summary of block **426** in a blueprint for the input app (block **428**).

The application sends the blueprint to a consumer application (block **430**). The application ends process **400** thereafter.

Thus, a computer implemented method, system or apparatus, and computer program product are provided in the illustrative embodiments for creating an on-demand blueprint of a mobile application and other related features, functions, or operations. Where an embodiment or a portion thereof is described with respect to a type of device, the computer implemented method, system or apparatus, the computer program product, or a portion thereof, are adapted or configured for use with a suitable and comparable manifestation of that type of device.

Where an embodiment is described as implemented in an application, the delivery of the application in a Software as a Service (SaaS) model is contemplated within the scope of the illustrative embodiments. In a SaaS model, the capability of the application implementing an embodiment is provided to a user by executing the application in a cloud infrastructure. The user can access the application using a variety of client devices through a thin client interface such as a web browser (e.g., web-based e-mail), or other light-weight client-applications. The user does not manage or control the underlying cloud infrastructure including the network, servers, operating systems, or the storage of the cloud infrastructure. In some cases, the user may not even manage or control the capabilities of the SaaS application. In some other cases, the SaaS implementation of the application may permit a possible exception of limited user-specific application configuration settings.

The present invention may be a system, a method, and/or a computer program product at any possible technical detail level of integration. The computer program product may include a computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of the present invention.

The computer readable storage medium can be a tangible device that can retain and store instructions for use by an instruction execution device. The computer readable storage medium may be, for example, but is not limited to, an electronic storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer readable storage medium includes the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a static random access memory (SRAM), a portable compact disc read-only memory (CD-ROM), a digital versatile disk (DVD), a memory stick, a floppy disk, a mechanically encoded device such as punch-cards or raised structures in a groove having instructions recorded thereon, and any suitable combination of the foregoing. A computer readable storage medium, as used herein, is not to be construed as being transitory signals per se, such as radio waves or other freely propagating electromagnetic waves, electromagnetic waves propagating through a waveguide or other transmission media (e.g., light pulses passing through a fiber-optic cable), or electrical signals transmitted through a wire.

Computer readable program instructions described herein can be downloaded to respective computing/processing devices from a computer readable storage medium or to an external computer or external storage device via a network, for example, the Internet, a local area network, a wide area network and/or a wireless network. The network may comprise copper transmission cables, optical transmission fibers, wireless transmission, routers, firewalls, switches, gateway computers and/or edge servers. A network adapter card or network interface in each computing/processing device receives computer readable program instructions from the network and forwards the computer readable program instructions for storage in a computer readable storage medium within the respective computing/processing device.

Computer readable program instructions for carrying out operations of the present invention may be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, configuration data for integrated circuitry, or either source code or object code written in any combination of one or more programming languages, including an object oriented programming language such as Smalltalk, C++, or the like, and procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program instructions may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider). In some embodiments, electronic circuitry including, for example, programmable logic circuitry, field-programmable gate arrays (FPGA), or programmable logic arrays (PLA) may execute the computer readable program instructions by utilizing state information of the computer readable program instructions to personalize the electronic circuitry, in order to perform aspects of the present invention.

Aspects of the present invention are described herein with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions.

These computer readable program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer readable program instructions may also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to function in a particular manner, such that the computer readable storage medium having instructions

stored therein comprises an article of manufacture including instructions which implement aspects of the function/act specified in the flowchart and/or block diagram block or blocks.

The computer readable program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device to cause a series of operational steps to be performed on the computer, other programmable apparatus or other device to produce a computer implemented process, such that the instructions which execute on the computer, other programmable apparatus, or other device implement the functions/acts specified in the flowchart and/or block diagram block or blocks.

The flowchart and block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of instructions, which comprises one or more executable instructions for implementing the specified logical function(s). In some alternative implementations, the functions noted in the blocks may occur out of the order noted in the Figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts or carry out combinations of special purpose hardware and computer instructions.

What is claimed is:

1. A method comprising:

performing, using a processor and a memory, an analysis of computer usable code comprising a mobile app, wherein performing the analysis produces a utilization summary indicating a number of times an element has been used relative to a particular screen and a number of times the element has been used relative to any screen, the analysis determining each user interface (UI) configuration in a set of UI configurations that is reachable in a use of the mobile app;

detecting, through the analysis of the computer usable code, a set of elements used in the mobile app relative to a selected UI configuration from the set of UI configurations;

analyzing, using the processor and the memory, a function performed by a selected element from the set of element relative to the selected UI configuration;

matching the function performed by the selected element with a function identified in a hierarchy of elements, the hierarchy being applicable to a plurality of mobile apps;

assigning a category of the function identified in the hierarchy to the selected element; and

outputting in a blueprint of the mobile app, the category of the selected element and a numerosity of occurrences of the selected element in the mobile app.

2. The method of claim **1**, further comprising:

computing a number of times the selected element is used in the selected UI configuration via a plurality of paths in the mobile apps, the number of times forming the numerosity of occurrences.

3. The method of claim **1**, further comprising:

computing a number of times the selected element can be used in any UI configuration in the set of UI configurations via a plurality of paths in the mobile apps, the number of times forming the numerosity of occurrences.

4. The method of claim **1**, wherein the blueprint is constructed automatically on-demand.

5. The method of claim **1**, wherein the hierarchy is a version of a general hierarchy, the version being specific to an operating system on which the mobile app is configured to operate.

6. The method of claim **1**, wherein the function performed by the selected element comprises a manner in which the selected element is used in the selected UI configuration.

7. The method of claim **1**, wherein the function performed by the selected element comprises an operation implemented in a code of the selected element for use in the selected UI configuration.

8. The method of claim **1**, further comprising:

determining a name used for the selected element relative to the selected UI configuration, wherein the function performed by the selected element is discoverable from the name.

9. The method of claim **1**, further comprising:

analyzing, as a part of performing the analysis of the mobile app, code of the mobile app, wherein the set of elements is detected through the analysis of the code.

10. The method of claim **1**, wherein a first element in the set of elements is rendered visibly on the selected UI configuration, wherein the first element one of (i) provides visual information and (ii) receives an input relative on the selected UI configuration.

11. The method of claim **1**, wherein a first element in the set of elements is invisible on the selected UI configuration, wherein the first element implements a function configured in the mobile app relative on the selected UI configuration.

12. The method of claim **1**, further comprising:

receiving a reference to the mobile app, wherein the analysis of the mobile app accesses the mobile app using the reference.

13. The method of claim **1**, wherein the UI configuration comprises a graphical layout presentable as a screen on a UI.

14. The method of claim **1**, wherein the use comprises navigating through a set of features of the mobile app.

15. A computer usable program product comprising one or more computer-readable storage mediums, and program instructions stored on at least one of the one or more storage mediums, the stored program instructions comprising:

program instructions to perform, using a processor and a memory, an analysis of computer usable code comprising a mobile app, wherein performing the analysis produces a utilization summary indicating a number of times an element has been used relative to a particular screen and a number of times the element has been used relative to any screen, the analysis determining each user interface (UI) configuration in a set of UI configurations that is reachable in a use of the mobile app;

program instructions to detect, through the analysis of the computer usable code, a set of elements used in the mobile app relative to a selected UI configuration from the set of UI configurations;

program instructions to analyze, using the processor and the memory, a function performed by a selected element from the set of element relative to the selected UI configuration;

program instructions to match the function performed by the selected element with a function identified in a hierarchy of elements, the hierarchy being applicable to a plurality of mobile apps;

program instructions to assign a category of the function identified in the hierarchy to the selected element; and

program instructions to output in a blueprint of the mobile app, the category and a numerosity of occurrences of the selected element in the mobile app.

16. The computer usable program product of claim **15**, further comprising:

program instructions to compute a number of times the selected element is used in the selected UI configuration via a plurality of paths in the mobile apps, the number of times forming the numerosity of occurrences.

17. The computer usable program product of claim **15**, wherein the computer usable code is stored in a computer readable storage medium in a data processing system, and wherein the computer usable code is transferred over a network from a remote data processing system.

18. The computer usable program product of claim **15**, wherein the computer usable code is stored in a computer readable storage medium in a server data processing system, and wherein the computer usable code is downloaded over a network to a remote data processing system for use in a computer readable storage medium associated with the remote data processing system.

19. A computer system comprising one or more processors, one or more computer-readable memories, and one or more computer-readable storage devices, and program instructions stored on at least one of the one or more storage devices for execution by at least one of the one or more processors via at least one of the one or more memories, the stored program instructions comprising:

program instructions to perform, using a processor and a memory, an analysis of computer usable code comprising a mobile app, wherein performing the analysis produces a utilization summary indicating a number of times an element has been used relative to a particular screen and a number of times the element has been used relative to any screen, the analysis determining each user interface (UI) configuration in a set of UI configurations that is reachable in a use of the mobile app;

program instructions to detect, through the analysis of the computer usable code, a set of elements used in the mobile app relative to a selected UI configuration from the set of UI configurations;

program instructions to analyze, using the processor and the memory, a function performed by a selected element from the set of element relative to the selected UI configuration;

program instructions to match the function performed by the selected element with a function identified in a hierarchy of elements, the hierarchy being applicable to a plurality of mobile apps;

program instructions to assign a category of the function identified in the hierarchy to the selected element; and

program instructions to output in a blueprint of the mobile app, the category and a numerosity of occurrences of the selected element in the mobile app.

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